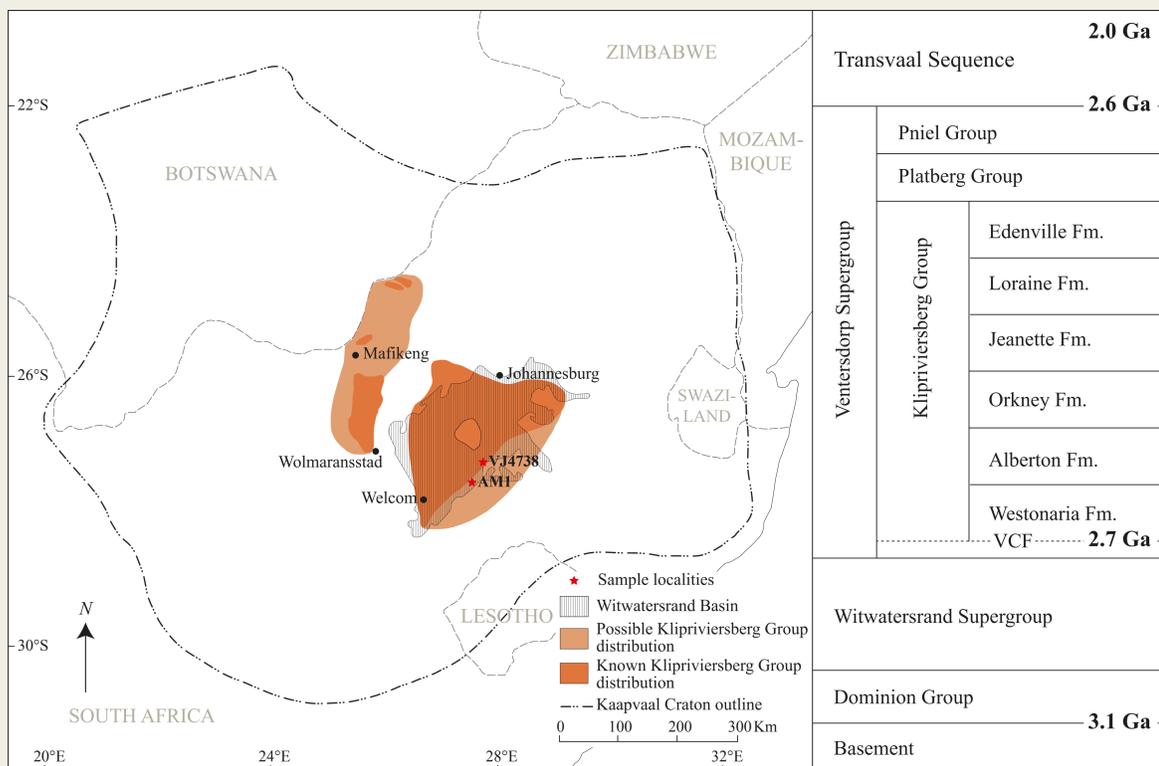


New geochronological constraints on the Klipriviersberg Group: defining a new Neoproterozoic large igneous province on the Kaapvaal Craton, South Africa

MASTER'S THESIS IN GEOLOGY BY JOAEN STAMSNIJDER, 2017

The Kaapvaal Craton in southern Africa hosts a rich and pristine geological history with many geological units and events in need of better age constraints. One is the Neoproterozoic Ventersdorp Supergroup, with the Klipriviersberg Group, and underlying successions of the Meso- to Neoproterozoic Witwatersrand Supergroup, of which the latter is world-wide known for its association with gold findings. By extracting baddeleyite from intrusive mafic sills from the Witwatersrand sediments, we have obtained critical age constraints for these successions using U–Pb geochronology on baddeleyite. This study indicates that the true age of the Klipriviersberg Group is 2787 Ma, as opposed to a previous study showing an age of 2714 Ma. We suggest that the Klipriviersberg Group lavas, and coeval units, may constitute a bimodal Large Igneous Province at 2782–2788 Ma on the Kaapvaal craton.



Problems:

The Klipriviersberg has been dated to 2714 Ma, which is younger than the stratigraphically overlying Platberg Group correlative rocks which have been dated to 2733 Ma.

Rapid emplacement of the Klipriviersberg Group lavas, expressed by geochemical homogeneity and lack of interbedded sediments, in addition to the conformably underlying Ventersdorp Conglomerate Formation (VCF), which has been dated to minimal 2780 Ma, indicates that the 2714 Ma Klipriviersberg age is erroneous.

Aims:

(1) Evaluate if two mafic sills (samples VJ4738 and AM1) from the Witwatersrand sediments belong to a system of magmatic feeders to the overlying volcanic Klipriviersberg Group lavas.

(2) Test if LA-ICP-MS is feasible for U–Pb dating baddeleyite, compared to ID-TIMS U–Pb on baddeleyite.

Simplified geological map showing the distribution of the Klipriviersberg Group rocks in South Africa, coupled with a general stratigraphic column of the Witwatersrand Basin. Ages are in Giga-annum (Ga).

Methodology

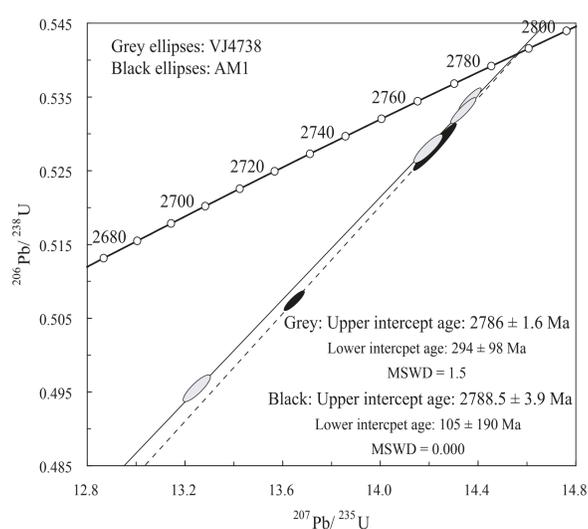
Two mafic drill core samples, northeast of Welkom in South Africa in the vicinity of Kroonstad, were selected for sampling using U–Pb geochronology on baddeleyite. The sample localities are shown in the figure above. Both mafic sills are situated within the Witwatersrand Supergroup succession immediately stratigraphically below the Klipriviersberg Group basalts at the base of the Ventersdorp Supergroup.

Baddeleyite grains within the dolerite sills were extracted and analysed using isotope dilution thermal ionization mass spectrometry (ID-TIMS) and complementary laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS).

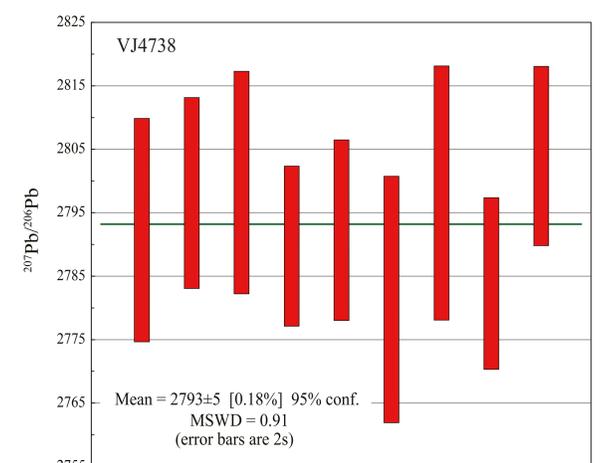
Conclusions

- (1) The mafic sills belong to a system of feeders to the Klipriviersberg Group, and the 2787 Ma age obtained in this study is the true age of the Klipriviersberg Group lavas.
- (2) The LA-ICP-MS is feasible for obtaining relatively precise and accurate single baddeleyite $^{207}\text{Pb}/^{206}\text{Pb}$ ages for Neoproterozoic intrusions.
- (3) The 2787 Ma sets a minimum age for the gold mineralization in the Witwatersrand.
- (4) The new age constraint infers a 70 million years shorter depositional time of Witwatersrand successions.
- (5) These results suggest a bimodal LIP at 2782–2788 Ma on the Kaapvaal craton.

A ID-TIMS



B LA-ICP-MS



U–Pb geochronological results. ID-TIMS data for both samples is visualised in a concordia diagram (A). $^{207}\text{Pb}/^{206}\text{Pb}$ weighted mean from the LA-ICP-MS data is visualised in a boxplot (B).

Result

The concordia diagram (above, A) illustrates the U–Pb ID-TIMS data for VJ4738 (grey) and AM1 (black). VJ4738 yields an upper intercept crystallization age of 2786 ± 2 Ma (MSWD=1.5), which can be compared with the U–Pb ID-TIMS age of AM1, which yields a preliminary upper intercept crystallization age of 2789 ± 4 Ma. A weighted mean of the two U–Pb ID-TIMS ages yield a 2787 ± 2 Ma (MSWD=1.8) age and is within error of the LA-ICP-MS result (above, B), which gives a $^{207}\text{Pb}/^{206}\text{Pb}$ weighted mean crystallization age of 2793 ± 5 Ma (MSWD=0.91). Hence, both methods provide ages that marginally overlap within given 2σ uncertainties.

We interpret the 2787 ± 2 Ma age (the weighted mean of the two U–Pb TIMS ages) for the dolerite intrusions reported in this study, to be the age of eruption for the Klipriviersberg Group flood basalts.